

WASHINGTON

# SCIENCE TRENDS

HIGHLIGHTS

- \* ELECTRICAL PROPULSION
- \* TECHNICAL TRENDS
- \* GROUND EFFECT MACHINES
- \* RESEARCH CHECKLIST
- \* PUBLICATION CHECKLIST

Vol. V, No. 21

February 6, 1961

## \* ELECTRICAL PROPULSION TRENDS

Studies by the U. S. Army's Diamond Ordnance Fuze Laboratories indicate that an electrical propulsion system can provide marked, new capabilities in land mobility -- and that fuel cell systems offer the best possibilities of providing the necessary power.

However, these studies also indicate that major technical advances are required both in terms of fuel cells and motors before a practical objective in this field can be met. Research programs are being accelerated and organizations with specific proposals in these areas can expect to be heard with interest.

Two Major Problems: An official connected with the Government program says that two major breakthroughs in materials may be required:

- ✓ A material with the same conductivity and mechanical strength as copper.
- ✓ A material with the same magnetic permeability and maximum flux density as high grade electrical steel.

In both cases, the new material would have to be very much lighter than the materials they replace, and would have to have equal or superior properties in other respects.

Possibilities -- A fuel cell, electric propulsion system, should it become feasible, could offer a number of advantages. Among these are said to be improved fuel logistics through greater efficiency, reducing fuel consumption at idle in a motionless vehicle -- and, providing certain research objectives can be met -- the possibility of using a variety of fuels.

In addition, possibilities include flexibility and freedom in vehicle design as far as power plant envelope is concerned; less field maintenance than is necessary with conventional power plants and more tactical freedom than possible with existing Army vehicles because of lower noise level, lower operating temperature and improved vehicle silhouette.

System Components -- Studies indicate that the fuel-cell power pack appears to be the "most reasonable choice" for future Army vehicles. Control would have to include regulating the input of fuel and reactants, and series-parallel switching of the individual cells in the pack. This would supply the motor with the required voltage-current relationship as motor torque and power output change in relation to changes in vehicle motion. Light-weight, high-speed, small-size low-torque motors are a possibility. Possible transmissions include conventional straight mechanical, mechanical with hydraulic torque converter or hydrostatic and electric motor-mechanical transmissions designed as part of vehicle wheels.

(Further details can be found in DOFL Report TR-777, "A Study of Electrical Propulsion of Ordnance Land Vehicles" and available through military channels or at \$1 from OTS, U. S. Department of Commerce, Washington 25, D. C.

## TECHNICAL TRENDS

- A detailed summary of the outlook for the electronic industry in 1961, and a review of 1960 developments is available on request. Single Copies Free. Write Electronics Division, BSDA, U. S. Department of Commerce, Washington 25, D. C. for Electronics Outlook, ER-60-88. ✓✓✓ The Atomic Energy Commission has revised its testing prices for high efficiency filter units. Details are in Release 118, available from Safety and Fire Protection Branch, U. S. AEC, Washington 25, D. C. ✓✓✓ General Services Administration, Washington 25, D. C. is looking for bids for all or part of the former U. S. Naval Ordnance plant in South Charleston, West Virginia, used for producing armor plate. Some machinery and equipment will also be up for sale and removal from the site.
- A survey and analysis of current policies, practices and procedures of educational institutions in handling patent problems is being prepared by the Office of Patent Policy Survey, National Academy of Sciences, Washington 25, D. C. ✓✓✓ Engineering freshmen enrolling in the fall term of the current Academic Year dropped by 100 to 67,600. Only a few years ago, in 1957, the comparable total was 78,800. However, enrollments for advanced degrees continue to increase. ✓✓✓ A theoretical research group in New York City, to be known as the Goddard Institute for Space Studies, is being established by the NASA. A staff of 50 will work closely with the faculties of universities and research institutions in the area. ✓✓✓ General Atomic Division of General Dynamics Corporation will build a Beryllium Oxide Experimental Reactor at the Atomic Energy Commission's testing station in Idaho. The work may lead to a maritime propulsion system offering advantages in economy, weight, compactness and inherent safety.
- The National Bureau of Standards now has available for sale two new gamma-ray standard samples of radionuclides, scandium-46 and manganese-54. For information write E. M. Zandonini, Radioactivity Standard Samples, National Bureau of Standards, Washington 25, D. C. ✓✓✓ The U. S. Internal Revenue service is warning taxpayers to "consider carefully" implications of tax deductibility contained in some recent advertising for tours described as "professional seminars." ✓✓✓ Atomic Energy Commission will conduct an unclassified symposium on uranium carbides as reactor fuel materials at AEC Headquarters on April 4, 1961. Inquiries should be directed to Industrial Cooperation Branch, Division of Reactor Development, U. S. Atomic Energy Commission, Washington 25, D. C. ✓✓✓ Statistics on the Communications Equipment Industry, indicating a 1961 decline, available from Communications Industries Division, Business and Defense Services Administration, Washington 25, D. C. Ask for Announcement ER-60-13. ✓✓✓ The U. S. Naval Training Device Center, Port Washington, New York, is interested in hearing from firms with experience in video recording and playback devices to be used in recording inflight radar presentations for ground playback in a tactics simulator. Write to the Center, ATTN: Code 2552 by February 10, 1961.
- Information on National Science Foundation programs, under which undergraduates work alongside scientists of more than 250 colleges and universities beginning this summer, is available from the Information Office, NSF, 1951 Constitution Avenue, N. W., Washington 25, D. C. Ask for NSF-61-102. ✓✓✓ Review and Outlook for the Chemical and Allied Products Industries is available from the Chemical and Rubber Division, BSDA, Washington 25, D. C. Ask for Announcement ER-60-69. ✓✓✓ Information on a four-week Reactor Laboratory Institute during the summer for college and university faculty members is available from W. J. Sturm, Argonne National Laboratory, Argonne, Illinois. ✓✓✓ Information on Atomic Energy Commission internships for outstanding college or law school graduates is available in Announcement D-30 from the Information Office, U. S. AEC, Washington 25, D. C. ✓✓✓ Announcement D-11 from the same office provides details of an eight-week institute to be held at Oak Ridge, Tennessee, for physics faculty members of small colleges.

\* SPECIAL SUMMARY REPORT -- GROUND EFFECT MACHINES

Washington SCIENCE TRENDS was probably the first publication to bring its readers comprehensive summaries of the "state of the art" and contract opportunities in the field of air cushion vehicles or Ground Effect Machines (GEMS).

Here is a new official summary of all U. S. Military GEM Research Programs;

\* OFFICE OF NAVAL RESEARCH

- Theoretical Study of GEMS - Aerophysics Corporation -- This task is to perform analytical investigations of the flow fields about certain types of aerodynamic devices operating in close proximity to the ground or water. Of primary interest, is the annular jet type ground effect machine (GEM), but work will begin in the area of analyzing the flow field and resulting aerodynamic forces on a conventional wing operating in ground effect. Efforts on the annular nozzle will be concentrated in the forward flight regime, because the hovering case is fairly well understood.
- GEM Propulsion System Matching - AiResearch Manufacturing Company of Arizona -- This is a continuation of a parametric study of the matching of propulsion systems to the ground effect machine. The first phase of this task emphasized the overall vehicle by encompassing a wide range of mission parameters. The results of this approach can be used to indicate general trends and for preliminary design. However, the preliminary results do not suffice for detailed design applications due to the vast number of assumptions involved. This continuation will permit additional, more detailed investigation of fan blade design, fan-duct matching at partial power, air drive systems, fan duct geometry at the fan exit, fan mounting procedures, and optimum integrated propulsion systems will be investigated.
- GEM-Stability and Control Study - AiResearch Manufacturing Company of Arizona -- This work involves an analytical study to determine the effect of various GEM design and operating parameters on the response characteristics of the vehicle. Included in the study will be an investigation of gyroscopic effects with regard to system damping. Test work will be initiated to obtain damping coefficient data for various parameters. System characteristics during vibration in the vertical mode and about the center of gravity will be measured.
- GEM Morphology Study - Bell Aircraft Corporation -- This study is intended to compare the potential performance of ground effect machines as determined from existing data and concurrent research with the desirable accomplishment of a number of possible military missions. Areas of operation in which the principle of the Ground Effect Machine may prove particularly useful for performing such missions have been analyzed in an attempt to delineate the detailed design problems which must be solved to adapt the Ground Effect Machine to practical use. Initial information was collected from other research investigators and from potential military users of such machines. This information, with continuing modifications based on new research results, will be used to form study matrices of mission requirements and significant vehicle parameters. Integration of these matrices will then present a preliminary representation of the optimum configuration for performance of the specified mission.



\* OFFICE OF NAVAL RESEARCH (Continued)

- Annular Nozzle Proximity to Free Water Surface - University of California --  
The object of this task is to conduct a theoretical and experimental investigation of a vertical annular jet in proximity to a water surface. Tests are being conducted for stationary and moving jets (plane of motion parallel to the plane of the water surface) over smooth water and water with waves. Some of the most important features of the investigation are to study the stability and wave-making characteristics of the jet. Thrust augmentation, drag, and pitching moment measurements are being done.
- Annular Ejector Tests - Hiller Aircraft Corporation -- This task is intended to investigate the thrust augmentation of a full-scale annular ejector. Having demonstrated the potential gains in augmentation of the annular configuration, and having verified these gains by preliminary experiments with a full scale test rig employing turbojet engine exhaust; it is now necessary to extend the work in order to establish optimum ground effect configuration. In addition, the effect of refinements to the full scale test rig will be evaluated to reflect the finding of small scale tests.
- Special GEM Configuration - Hiller Aircraft Corporation -- This investigation has evaluated two special ground effect machine configurations which have excellent potential for economical high speed forward flight. Both theoretical and experimental studies were included in the program to determine the performance, and stability and control characteristics of these GEM configurations in hovering flight. The theoretical studies were also extended to the forward flight regime.
- Jets and Turbulence Investigation - State University of Iowa -- This project consists of the following experimental and theoretical investigation in Hydromechanics: (1) Annular Jet studies, (2) Axisymmetric gravity waves, (3) Instrumentation for experimental hydrodynamic research, and (4) Jet cavitation. For item one a precise Annular Jet with interchangeable mouthpieces is being used to study: (a) ratio of area of jet flow to nozzle base area, (b) jet angle, and (c) angle of tilt of nozzle over land and water, moving and stationary. In addition, altitude ratio and jet momentum effects for an Annular Jet moving over water are being studied. The gravity waves program includes a study of energy components for the waves for various conditions. Instrumentation work includes development of turbulence data analyzing equipment and use of hot-film anemometers in salt water.
- Steady Flow Ejector Investigation - Lockheed Aircraft Corporation -- This task is intended to provide information which will improve the reliability of predicting thrust augmentation for ejector application to aircraft and Ground Effect Machines. The program is both analytical and experimental with emphasis on tests to be made using a new test rig incorporating provisions for wide flexibility.
- GEM Stresses in Waves - Netherlands Ship Model Basin -- It is the purpose of this task to obtain and evaluate experimental measurements of the stresses on two ground effect machine models while ditching in still water and in various wave conditions. Vertical and longitudinal accelerations will be measured. One of these models will also be tested floating in waves at zero speed. Wave heights in all tests will be chosen in such a way that wave dimensions up to sea state 5 will be simulated.
- Annular Jet Seals for GEM Application - Carl Weiland -- This task comprised experimental tests of a model designed to evaluate a pressure seal system for annular jets. The seal system essentially comprised a series of annular jets simulating a labyrinth seal.



\* OFFICE OF NAVAL RESEARCH (Continued)

- GEM Operation Over Water - Cleveland Pneumatic Industries -- The purpose of this task is to conduct an investigation of the physical processes which govern the general over-water stability and control characteristics of Ground Effect Machines, directed toward the development of criteria which will provide general design guidance with respect to stability and control. In particular, the investigation shall include the general problem of stability, including response to a generalized forcing function, the effect on the vehicle of annular jet interaction with a deformable surface; and the general aspects of the characteristics of control systems compatible with human operation.
- GEM Structures Study - Ryan Aeronautical Company -- It is the purpose of this task to study the structural problems of ground effect machines, and to derive preliminary structural design criteria which may be used to define the probable weight and cost of basic structure to be employed in a large family of GEM's. It is thought, for example, that GEM's for some possible applications will use aircraft materials and construction techniques, while others will be structurally more akin to surface vehicles.
- GEM Internal Flow Study - Vehicle Research Corporation -- This investigation consisted of theoretical and experimental analyses of internal flows in Ground Effect Machines (GEM's). The theoretical analysis considered the momentum flux through and the losses sustained in a systematic and generalized family of inlets, diffusers, turning vanes, connecting passages and nozzles. Experimental techniques were used to explore problem areas, to yield data on aspects of the problem not amenable to analytical treatment, and to confirm the theoretical results through quantitative force measurements. The analysis included both plenum and annular jet type vehicles.
- GEM Propulsive Screen - Vehicle Research Corporation -- This investigation will consist of an analytical study of a diffuser shaped ground effect machine. The GEM model will be formulated in parametric terms and both the sustaining and propulsive forces will be calculated. The parameters will be varied to include the diffuser configuration of the plenum chamber, the width and mass flow of the jet, the inward and rearward angle of disposition of this jet as a function of forward speed, and the machine performance attained thereby as a function of power required. Experimental and model techniques will be employed to explore problem areas, to yield data on aspects of the problem not amenable to analytical treatment, and to confirm the theoretical results.
- Wind Tunnel Tests of GEM Models - University of Wichita -- This task involved wind tunnel tests which will provide a large amount of force data on a total of 24 geometric configurations of annular jet and plenum chamber type Ground Effect Machine models, plus a great many points of pressure data on ground plane, base plates and upper model surfaces.

\* BUREAU OF NAVAL WEAPONS

- Large Ground Effect Airborne Logistics Vehicle Study - Convair, San Diego -- A Division of General Dynamics has completed a study of the feasibility of large airborne logistics vehicles operating within ground effect. Design parameters have been established for vehicles capable of carrying 500,000 to 1,000,000 pounds of cargo over the ocean at a speed of approximately 100 knots and capable of taking off and alighting from both water and land. Both nuclear and chemical power systems were considered.
- Airflow Study of the Gyrodyne GEM - Gyrodyne Company of America -- Gyrodyne is to obtain aerodynamic data of the air flow through the duct system and beneath the base plate of their six foot diameter GEM. In addition Gyrodyne will investigate methods to improve the controllability and forward speed of the GEM. Flight tests to check out the various methods will be made.

(To be continued.)

## RESEARCH CHECKLIST

- RESOLVING POWER IN LENSES: The National Bureau of Standards has been able to find no significant differences in various types of test patterns used to measure the resolving power of the precision lenses in air-mapping cameras. Tests show that the plane of best definition in these lenses -- which is the focal plane found to have the highest average value for resolving power -- can be determined equally well with each type of pattern tested. In addition, studies indicate that resolving power is primarily a qualitative characteristic of lenses -- and that its quantitative aspects should not be overemphasized.

(For further details write National Bureau of Standards, Office of Technical Information, Washington 25, D. C., regarding "Measuring Resolving Power in Precision Lenses.")

- FIBER ALIGNMENT DEVICE: A new electrostatic device to speed measurement of the fineness of wool-fiber sections has been developed under Government contract. The experimental tool arranges fibers in oil before they are measured indirectly under a microprojector. The images cast by the projector are compared with a wedge scale, a special rule used for this purpose. The information gained is used in determining the best uses for different lots of wool, as well as for comparing and evaluating the quality of various fibers. The device consists of a chassis containing a high voltage transformer, a sample chamber and an indicating lamp; a slide holder and a protective cover plate.

(R&D reported by Information Office, U. S. Department of Agriculture, Washington 25, D. C. Some further details in Announcement USDA 307-61.)

- PURIFICATION OF SEA WATER WITH GAS HYDRATES: Broad study of various gas hydrate methods of desalting sea water has been completed by the Syracuse University Research Institute for the Office of Saline Water of the Department of Interior. In general, the gas hydrate method of desalting sea water has several promising advantages which have not been studied in much detail -- although first suggested in 1942. It has the advantages of any freezing method, such as low heat and energy requirement, absence of scale forming problems, etc. In addition, it operates at a freezing temperature of 50 to 60° F. so that its refrigeration system demands are well below those of other freezing methods. Detailed information of more than twenty different hydrating agents are presented in the Syracuse report.

("The Properties of Gas Hydrates and Their Use in Demineralizing Sea Water", available at \$2.00 from OTS, U. S. Department of Commerce, Washington 25, D.C.)

- WEAR OF CERAMIC AND CERMET BEARINGS: A mathematical relationship describing the rate at which ceramic and cermet materials will wear during high speed sliding has been determined at the Battelle Memorial Institute under an Air Force contract. Research also showed that the predominant wear mechanism under these conditions appeared to involve the formation of hot spots at the points of relative roughness. Fracture of the material occurred near the hot spots as a result of thermal stresses. Promising commercial materials cited by the Battelle researchers for use as high-temperature dry sliding bearings, gas bearings, and seals include several cermets and ceramics.

(Details of this work are contained in WADD Technical Report 60-54, available through military channels or at \$1.50 from OTS, U. S. Department of Commerce, Washington 25, D. C.)

□ ARMY TESTING STEREOMAT: The Army is testing a Canadian device designed to reduce the time required to contour aerial photographs. The unit, a "Stereomat", employs photo-electric cell "flying spot" random scanning and other electronic techniques to automate the time-consuming task of establishing contours for maps made from aerial photographs. The Army points out that enough photographs can be taken from a single aircraft in one day to keep a conventional, manually-operated photogrammetric plotting machine busy for an entire year.

(R&D by Hunting Associates, Limited, reported by Technical Liaison Office, U. S. Army Engineer Research and Development Laboratories, Fort Belvoir, Virginia.)

□ FIBER OPTICS RESEARCH: The U. S. Air Force has signed a contract with the American Optical Company, Southbridge, Mass. aimed at improving the quality of fused fiber optics face plates for cathode ray tubes. The contract also calls for work on tapered bundles of fiber optics, which are an essential part of ultra high-speed photographic lenses being developed for the Air Force.

□ STANDARDIZATION OF RADIATION THRESHOLD FOIL: Standard procedures for fabricating threshold foils have been devised by Aerojet-General Nucleonics under an Air Force contract. This standardization of foil techniques will make it possible to correlate many of the measurements made at nuclear laboratories which could only be interpreted on the basis of a single test under a system previously used. The foils are used to measure the threshold of neutron flux at various locations around nuclear reactors.

(WADC Technical Report 59-607 available through military channels or at \$2.50 from OTS, U. S. Department of Commerce, Washington 25, D. C.)

□ MERCHANT SHIP DEGAUSSING: Simplified degaussing system which could be employed to protect large ocean liners against magnetic mines in time of war is under development by the Navy. A method now of interest would locate certain degaussing cables on the outside of the hull, thus eliminating the need of removing interior paneling and of disturbing furniture, cables, piping or equipment. The new method visualizes the installation of coils through the ship's air ports, and is still under study. A trial shipboard installation may be made for evaluation purposes.

(R&D reported by F. J. Hara, Conversion Design Branch, U. S. Navy, Bureau of Ships, Washington 25, D. C.)

#### ROYALTY-FREE PATENT

The following invention, developed at U. S. Government expense, is now available to U. S. industry, royalty-free. For patent number and details on licensing, write Service Department, Washington SCIENCE TRENDS, National Press Building, Washington 4, D. C. :

□ Electrical Connector for Flat Cables -- The patent covers a connector for making electrical connections at the ends of cables or connecting two or more cables, or printed circuits which -- to save weight and space -- are in the form of a thin, flat sheet, ribbon, tape, or strip of non-conductive base material.



## P U B L I C A T I O N   C H E C K L I S T

- NATIONAL SCIENCE FOUNDATION, annual report for 1960 outlining various research programs of the Foundation. Includes a complete list of NSF grants for research and fellowship awards as well as publications issued during the year. 310 Pages. \$1. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for National Science Foundation, Tenth Annual Report)
- STEROID SEARCH SYSTEM, a revised coding manual for use in a punched card system for conducting patent searches in the steroid art. 23 Pages. 25 Cents. (Write Publications Office, U. S. Department of Commerce, Washington 25, D. C. for Patent Office Research and Development Report No. 19)
- HEAT TREATMENT AND PROPERTIES OF IRON AND STEEL, a monograph designed to answer inquiries concerning this subject. Omits some theoretical aspects and technical details. Contains a complete listing of all current structural, tool and stainless steels, and their recommended heat treatments. 40 Pages. 35 Cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for National Bureau of Standards Monograph No. 18)
- NUCLEAR FUSION JOURNAL, a new quarterly published by the International Atomic Energy Agency reporting original work and review articles concerning plasma physics and controlled thermonuclear fusion research. \$10 per four issues. (Write to Publications Office, International Atomic Energy Agency, Kaerntnerring 11, Vienna 1, Austria)
- GOVERNMENT PROCUREMENT - 1960, a Congressional report on "The Lack of Competition in Military Procurement and Its Impact on Small Business." 32 Pages. Single Copies Free. (Write Select Committee on Small Business, U. S. Senate, Washington 25, D. C. for Report No. 4)
- BUREAU OF MINES RESEARCH, a detailed listing of nearly 9,000 articles written for scientific and technical journals in the United States and abroad by U. S. Bureau of Mines authors during the past 50 years. The index contains more than 14,000 key references and cross-references. \$1.75. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for "List of Journal Articles by Bureau of Mines Authors Published July 1, 1910 to January 1, 1960")
- CAPE CANAVERAL GEODETIC SURVEY, a detailed description of geodetic surveys of unusual accuracy required for Air Force tests of its Azusa Mod II electronic missile tracking system at Cape Canaveral, Florida. 14 Pages. 15 Cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for U. S. Coast and Geodetic Survey Technical Bulletin No. 13)
- NEW DEVELOPMENTS IN THE WELDING OF METALS, a fine review of Fusion and Resistance-Welding Processes; High Temperature Brazing and Solid-State Bonding Processes. Includes two new Soviet developments said to hold promise in specialized fields. Due primarily to Government red tape this Report of June, 1960 has become generally available only recently. 48 Pages. \$1.25. (Write OTS, U. S. Department of Commerce, Washington 25, D. C. for DMIC Report No. 131)

